THE TRAINING OF INDUSTRIAL ENGINEERS

Men and women are strangely hard to move or lead from their accustomed way. A sense of the difficulty of such change is perhaps the first feeling of most men who work in the science of management. Little by little, as the engineer goes forward, however, he begins to see that the possession of certain powers enables him to conquer not only hesitant men and recalcitrant machines, but baffling problems which involve both men and machines. And the powers which enable him to do these things are science and common-sense. Those are the two needs which the industrial engineer himself ardently desires to gain to a greater and greater degree. Those are the two needs which I present here as the basis of the training of men who intend to make the science of management their vocation.

I assume that no course in the science of management would be begun before the end of the Sophomore year in college. The man who reaches the Junior year of college or technical school must have had some training in science and mathematics or he would not be eligible to enter the scientific management course. He must have acquired some common-sense and scientific attitude on his way, and the knowledge of science and common-sense so gained should be sufficient to enable him to recognize that in electing scientific management he is deliberately electing to follow a long and arduous road. The problem before us, then, when we discuss the work of men electing industrial engineering courses, is not one of supplying common-sense to men who have none, but rather of taking men with some common-sense and some knowledge of science and raising what they have to the highest possible power.

How, then, can the industrial engineer become a scientist, attain the scientific attitude of mind? More difficult still, how can he obtain common-sense?

By welding the scientific work of the classroom with the shop-

work of the factory; by making the laboratory hours, hours that are spent with wage-earners striving for their daily wage, instead of with fellow-students who are studying rather than earning; by making the classroom hours full of the splendid life, spirit, and movement of American industry. Laboratory and classroom hours alike must be filled with reality rather than with pure theory or with theory quite unrelated to the practical world.

The ignorance of the American undergraduate as regards industry seems to me appalling. The matter of his courses, the content of his texts seem to the undergraduate to belong to a world quite separate from the busy, stirring factory world outside the academic walls. He must then, first of all, get in touch with the shop. And I insist that he can do that nowhere save in actual operating shops among men who are working for their daily wage. No shop practice in the school will produce a like result. Shop-sense is one of the most valuable possessions of the industrial engineer. That sense comes only through actual shop practice. Once possessed it means that the man has thereafter the freedom of the shop.

To attain the desirable ends of knowledge of science and possession of common-sense I propose that any course in the science of management shall consist of classroom work as outlined below and of laboratory work carried on in actual operating shops. That means that manufacturers who are broad-minded enough to be willing to assist the college, and instructors broad-minded enough to recognize the limitations of industry must co-operate in giving the laboratory instruction in shop practice to the students. I believe both groups of men exist and I feel that through their combined efforts the student should have an opportunity to spend the summers of his Sophomore and Junior years in actual shop practice, while three afternoons a week during the scholastic year should see him working in the shop.

What underlying thought must be before the men who make the courses?

Again to a definite question we can give a definite reply. The industrial engineer is dealing in all cases with both *men* and *machines*. He must study "man" in his relation to his industrial environ-

ment—not any single class of men, but all the men engaged in industry. He must study "machines," not alone in their relation to their product, but also in relation to the human beings who operate them. It is his task to bring the best that modern science has to the aid and well-being of man.

It is in the development of his pupil's studies of men that the wise teacher of scientific management will work most steadfastly in correlating the allied courses, mentioned later, in psychology and physiology, in economics and sociology, with the courses in the science of management, and with the work of living men and whirring machines. What percentage of flat failures occur because men have only "one side to their head," because they are quite unable to see the relation of many interweaving threads in a given problem, it is hard to tell. But I believe it is no small number. The industrial engineer must recognize the presence of many factors in a problem. He must solve equations of not only two unknown quantities, but of a dozen unknown quantities, so to speak. And the correlation of his courses in class with each other and with life will do much in the way of enabling him to do so.

It remains briefly to sketch the content of the direct courses on this subject and to state their desired end. To do this I use again the question form.

When should the work begin, and how much of the student's time should it occupy?

Direct work in scientific management should begin either at the end of two years or of four years in college. The direct and allied special classroom courses should occupy one full year of collegiate training, divided between two years' work, making a half-year's work in scientific management during both the Junior and Senior years. The shopwork should occupy two summer vacations and three afternoons a week during each of the two years.

What courses should be offered?

A dominant course in the science of management running through two years, allied with courses in economics, sociology, psychology, physiology, hygiene and sanitation, theory and practice of accounting. All these should be in addition to the student's more direct work in science, mathematics, English, and foreign

languages, which occupy the time of three out of the four collegiate years—if the courses are made undergraduate ones.

What should be the content of the scientific management courses given during the four half-years that comprise the Junior and Senior years of most colleges and technical schools?

The first half-year should be devoted to a general view of four picked industries—in order that the student may see industry more or less as a whole—and to the study of the principles of scientific management. The laboratory work for this course should consist of the broad outlined study of four plants from the time of the receipt of the first inquiry from the prospective customer to the final entry of the payment for the bill and the calculation of the cost. The classroom work for this course should be devoted to a thorough grounding in the basic principles of organization, and to study of the principles of scientific management.

It is most essential that the student should obtain at the very start a clear realization of the difference between system and science. It is most essential also that he should come to understand that, while certain problems solved for one industry may be solved for all industry, such general solutions cannot be presumed upon. He should know that every new business will contain new problems, which must be solved by the use of all the knowledge of the past plus all the imaginative genius he can hope to possess. That is to say, the student must learn that a mechanism used successfully in one place cannot be bodily transported to another with hope of instant success. By the end of the first half-year each individual taking the course should have come to realize that he is studying the principles of a science which are applicable to every case, not memorizing a set of rules or inheriting a stock of recipes. The study of four actual operating plants will aid him greatly in this realization.

The second half-year should be devoted in the classroom to a detailed study of the planning-room and the processes involved in getting work into the shop, of stores, routing, specifications, etc.—planning in general, in a word. The laboratory work should consist of actual planning-room experience in the shop.

It is entirely true that there is a question as to whether planning-

room experience should follow or precede shop training. It may, therefore, be a question whether planning should be put in this course. It is my own belief that the student will master his shop theory better the third half-year from the fact that he has discovered the basic reasons of the work in the planning-room. It should be noted, moreover, in this connection that I have assumed that the student has had a summer's experience in actual shop practice as a prerequisite of the course, and that he has had a half year of general preliminary study.

The third half-year should be devoted to a detailed study of work in the shop (especially of the teaching work of the functional foreman), of inspection, and of task work. All of this except the study of task work should be done in actual plants. The task work should be done on fellow-students in the shops of the school. No untrained man should ever be put on actual task-setting.

The third half-year offers a great opportunity to impress upon the student the importance of the teaching function of his work. The whole theory of functional foremanship is a theory of education and a great part of the time of an industrial engineer must be spent in teaching the men with whom he is working. Adequate powers of expression are by no means common among our recent graduates. The teacher of scientific management can never forget that the work of his pupils must show in the life-work of the men with whom they are dealing. The bridge-builder leaves a physical monument largely untouched by the later thought of men. The industrial builder must educate in such a way that his work will go progressively forward in the minds of men. That is true education, and education is true only when it obtains adequate expression.

The fourth half-year should be devoted to studies in bringing all the best that science offers to the aid of industry—to work in costs, to work in the determining of policies by studies of sales, purchasing, and the like, and to the co-ordination of the work of the three half-years already outlined.

The course of the fourth half-year should be broad enough to give the student some concept that great movements of trade exist and that they are factors which he must meet and use. The world is fairly well provided with men who can look after a few details.

It is very poorly provided with men who can care for great constructive work. One of the greatest industrial leaders of our time said to me the other day: "The greater the affairs of a corporation, the smaller the number of men who can deal with them. It seems to be a true inverse proportion. There are ten men who can think in a hundred thousand dollars, to one who can think in a million, and ten who can think in a million to one who can think in ten millions."

I should hardly expect any course to give an undergraduate a great grasp of comprehensive plans. There is, however, no reason why we should hitch our wagon to the lowest of the stars when we can find higher ones within our reach.

In the foregoing résumé of a course in the science of management I have made no reference to many subjects I should have been glad to consider, to reports and theses, to methods and policies. Considerations of brevity forbade. I must turn again to my catechism and end with three brief questions and three brief answers.

What should the allied courses teach?

The relation of man to industry and to his general environment.

What should the college courses in English teach?

The power of expression.

What should the work in scientific management teach?

That scientific management is a change of mental attitude (mental attitude, now, as always, the most powerful force among men) which makes employer and employee pull together instead of apart, which brings all that is best in science to the aid of every man in industry, and which, by its substitution of exact knowledge for the chaos of guess work and ignorance, makes progressively for justice and for the coming of the "new industrial day."

HOLLIS GODFREY

WEST MEDFORD, MASS.